

Parameter	Value	Unit
Initial temperature	25.0	°C
Final temperature	25.0	°C
Initial pressure	1.013	bar
Final pressure	1.013	bar
Initial volume	0.001	m ³
Final volume	0.001	m ³
Initial mass	0.001	kg
Final mass	0.001	kg
Initial density	1000	kg/m ³
Final density	1000	kg/m ³
Initial viscosity	0.001	Pa·s
Final viscosity	0.001	Pa·s
Initial thermal conductivity	0.6	W/m·K
Final thermal conductivity	0.6	W/m·K
Initial specific heat capacity	4182	J/kg·K
Final specific heat capacity	4182	J/kg·K
Initial enthalpy	4182	J/kg
Final enthalpy	4182	J/kg
Initial entropy	4182	J/kg·K
Final entropy	4182	J/kg·K
Initial internal energy	4182	J/kg
Final internal energy	4182	J/kg
Initial free energy	4182	J/kg
Final free energy	4182	J/kg
Initial Helmholtz free energy	4182	J/kg
Final Helmholtz free energy	4182	J/kg
Initial Gibbs free energy	4182	J/kg
Final Gibbs free energy	4182	J/kg
Initial chemical potential	4182	J/kg
Final chemical potential	4182	J/kg
Initial activity	1.0	
Final activity	1.0	
Initial fugacity	1.0	bar
Final fugacity	1.0	bar
Initial vapor pressure	1.013	bar
Final vapor pressure	1.013	bar
Initial boiling point	100.0	°C
Final boiling point	100.0	°C
Initial melting point	0.0	°C
Final melting point	0.0	°C
Initial freezing point	0.0	°C
Final freezing point	0.0	°C
Initial sublimation point	-78.5	°C
Final sublimation point	-78.5	°C
Initial critical temperature	373.15	°C
Final critical temperature	373.15	°C
Initial critical pressure	1.013	bar
Final critical pressure	1.013	bar
Initial critical density	322	kg/m ³
Final critical density	322	kg/m ³
Initial critical viscosity	0.001	Pa·s
Final critical viscosity	0.001	Pa·s
Initial critical thermal conductivity	0.6	W/m·K
Final critical thermal conductivity	0.6	W/m·K
Initial critical specific heat capacity	4182	J/kg·K
Final critical specific heat capacity	4182	J/kg·K
Initial critical enthalpy	4182	J/kg
Final critical enthalpy	4182	J/kg
Initial critical entropy	4182	J/kg·K
Final critical entropy	4182	J/kg·K
Initial critical internal energy	4182	J/kg
Final critical internal energy	4182	J/kg
Initial critical free energy	4182	J/kg
Final critical free energy	4182	J/kg
Initial critical Helmholtz free energy	4182	J/kg
Final critical Helmholtz free energy	4182	J/kg
Initial critical Gibbs free energy	4182	J/kg
Final critical Gibbs free energy	4182	J/kg
Initial critical chemical potential	4182	J/kg
Final critical chemical potential	4182	J/kg
Initial critical activity	1.0	
Final critical activity	1.0	
Initial critical fugacity	1.0	bar
Final critical fugacity	1.0	bar
Initial critical vapor pressure	1.013	bar
Final critical vapor pressure	1.013	bar
Initial critical boiling point	100.0	°C
Final critical boiling point	100.0	°C
Initial critical melting point	0.0	°C
Final critical melting point	0.0	°C
Initial critical freezing point	0.0	°C
Final critical freezing point	0.0	°C
Initial critical sublimation point	-78.5	°C
Final critical sublimation point	-78.5	°C

RX-AVC: Automatic Volume Control Algorithm

(Internal distribution only)

1 Background

The RX-AVC is an advanced audio function that automatically controls the received speech level and dynamic range. The AVC is a collection of 3 functions. The 3 functions can be activated both separately and together. The 3 functions are:

1. Automatic gain control (AGC)
2. Automatic volume increase and dynamic range compression (DRC) as a function of TX noise level
3. Dynamic range compression (DRC) for speakerphone

The following block diagram shows how the RX-AVC fits within the other speech modules in the RX and TX paths.

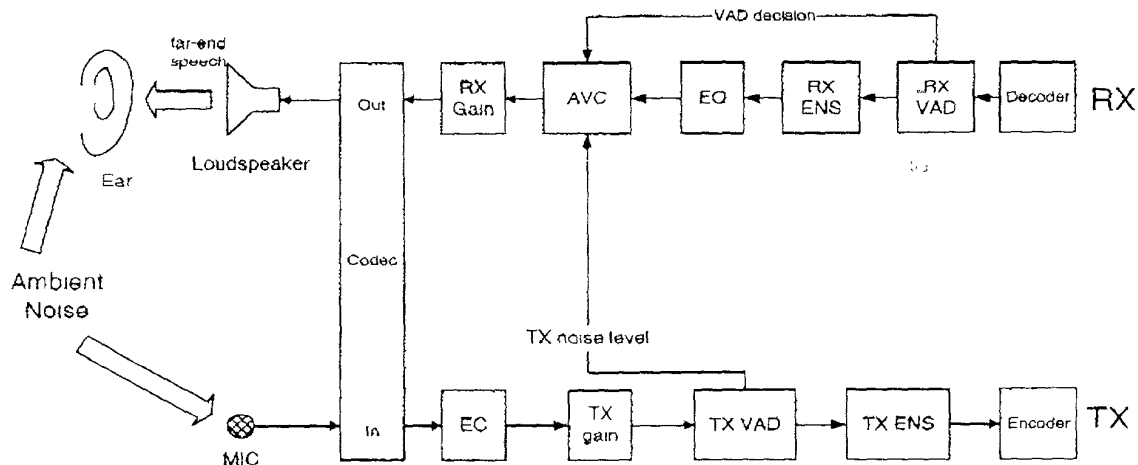


Figure 1: Audio path with RX-AVC.

2 Algorithm description

The total AVC gain is the sum of 3 gains:

1. AGC
2. DRC gain weighted by a maximum between two numbers: (1) a weight proportional to the TX noise level, (2) DRC GAIN FACTOR.
3. Additional constant gain whose value is weighted by TX noise level

Enabling flags (AGC_FLAG and NOISE_RESPONSE_FLAGS) gate the AGC and the noise-weighted gains. Figure 2 shows the algorithm block diagram.

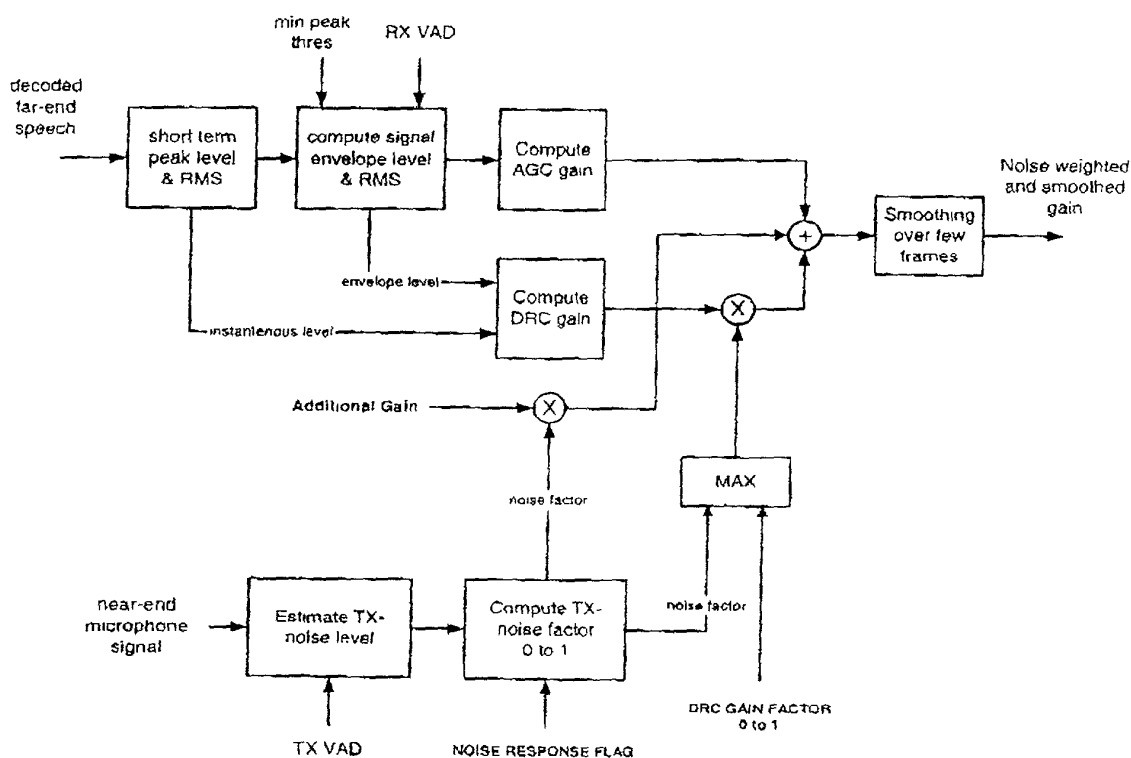


Figure 2: block diagram

2.1 Blocks description

2.1.1 short-term peak & short-term rms level

Computes maximal sample energy over a sub frame several samples (default=16)

Computes rms energy over the sub frame

2.1.2 Compute signal envelope level & speech-RMS

Envelope is updated if RX-VAD detected speech and if the local peak is above a threshold:

```
if (RX-VAD && local_peak > MIN_ENVELOPE)
{
    if (local_peak > envelope)
        envelope = min(local_peak, envelope + INCREMENT_PEAK) ;
    else
        envelope -= DECREMENT_PEAK ;

    if (rms > long_term_rms)
        long_term_rms += INCREMENT_RMS ;
    else
        long_term_rms -= INCREMENT_RMS ;
}
```

2.1.3 Compute AGC gain

Basic relation: $agc_gain = (LEVEL1 - envelope) ;$

Limitation 1: $agc_gain = \min(MAX_AGC_GAIN, agc_gain) ;$

Limitation2: $agc_gain = \min(MAX_RMS - long_term_rms, agc_gain) ;$

2.1.4 Compute DRC gain

Given the following noise dependent and RX- signal independent parameter:

$drc_gain = MAX_DRC_GAIN * \max(drc_gain_factor, noise_factor) ;$

Compute for each sub-frame the following gain (frame_drc_gain) as a function of its local peak and the envelope level as depicted in the following figure:

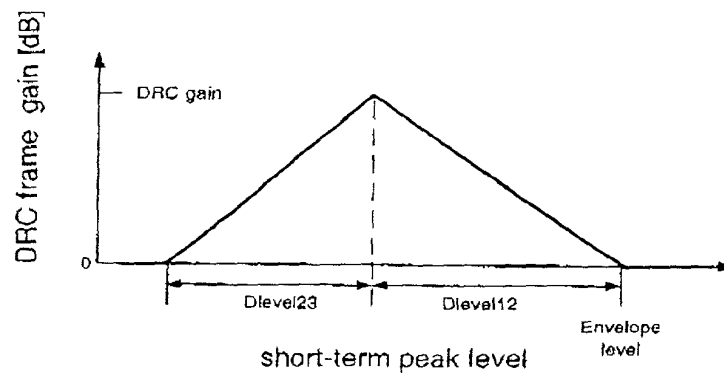


Figure 3: DRC gain function

2.1.5 Estimate TX noise level

See Period_alg.doc

2.1.6 Compute Noise factor

Noise factor is a function of noise level.

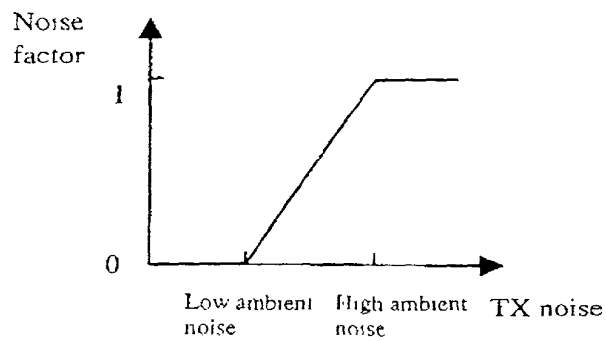


Figure 4: Noise factor

2.1.7 Gain smoothing

Signed exponential smoothing:

```
if (target_gain > smooth_gain_db)
```

```
    alfa = ALFA_UP ;
```

```
else
```

```
    alfa = ALFA_DOWN ;
```

```
smooth_gain_db = smooth_gain_db * (1-alfa) + alfa * target_gain ;
```

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3 Parameters

3.1 Tunable parameters

AGC_FLAG

AGC enable/disable control bit

NOISE_RESPONSE_FLAG

Enable/disable control bit for the ambient noise-induced automatic volume increase.

DRC_GAIN_FACTOR

Controls the amount of DRC, ranging from 0 to 0x7FFF. Default = 0.

LEVEL1

Target level for the RX-signal envelope level. Default value: -3 dBov (3 dB below clipping level).

HIGH/LOW_AMBIENT_NOISE:

See figure 3. The default values are -39 dBov (low) and -21 dBov (High). Increasing these thresholds will reduce the effect of the RX-AGC to noise. The thresholds should be modified if the TX analog path gain is changed. For example, if the TX analog codec gain is increased by X dB, these thresholds should be increased by the same X dB.

MAX_AGC_GAIN

Upper limit on the AGC gain in the module "Compute AGC gain" (see 2.1.3). The default value is set to 21 dB.

MAX_DRC_GAIN

Upper limit on the DRC gain in the module "compute DRC gain" (see 2.1.4). The default value is set to its maximum allowed value of 21 dB. Decreasing this parameter will decrease the effect of the DRC.

MAX_RMS

The AGC gain is limited so that the signal RMS after amplification does not exceed MAX_RMS (default = -15 dBov).

MIN_ENVELOPE

Signals whose envelope is smaller than this threshold do not affect the AGC

3.2 *Soft constants (default)*

NUM_SUB_FRAMES	(10)
SUB_FRAM_LEN	$(\text{FRAM_LEN}/\text{NUM_SUB_FRAMES} = 16)$
LOG_SUB_FRAM_LEN	$(10 * \log_{10}(\text{SUB_FRAM_LEN}) = 12)$
DLEVEL12 (see Figure 3)	(24)
DLEVEL23 (see Figure 3)	(26)
DECREMENT_PEAK	$(3 * \text{SUB_FRAM_LEN}/8000 = 3 \text{ dB/sec})$
INCREMENT_PEAK	$(1 = 1 \text{ dB/sub_frame})$
INCREMENT_RMS	$(10 * \text{SUB_FRAM_LEN}/8000 = 10 \text{ dB/sec})$
ALFA_UP (see 2.1.7)	0.1
ALFA_DOWN (see 2.1.7)	0.5